

California Regional Water Quality Control Board
Santa Ana Region

March 15, 2002

ITEM: 10

SUBJECT: Status Report on Big Bear Lake Total Maximum Daily Load (TMDL) Activities

Background

Big Bear Lake, created by the construction of the Bear Valley Dam in 1884, is a man made reservoir located in the San Bernardino Mountains in San Bernardino County, approximately 100 miles northeast of Los Angeles and 40 miles northeast of the City of San Bernardino (see the attached Figure). Big Bear Municipal Water District acquired title to the Dam, the land lying beneath the reservoir and the surface recreation rights of the Lake, and is responsible for managing the Lake. Bear Valley Mutual Water Company owns the water rights to the Lake.

The Big Bear Lake drainage basin encompasses 38.5 square miles and includes more than 10 streams. Local stream runoff and precipitation on the Lake are the sole source of water supply to the Lake. Big Bear Lake drains to Bear Creek, which is tributary to the Santa Ana River. Twelve percent of Big Bear Lake's drainage basin consists of the Lake itself. The US Forest Service (Forest Service) is the biggest landowner in the Big Bear area. Two ski resorts, Bear Mountain and Snow Summit, lease land from the Forest Service.

Big Bear Lake has a high water level of 6,743.2 feet above mean sea level (MSL), a water surface of 2,971 surface acres at high water level, and a maximum lake capacity of 74,268 acre-feet. The maximum depth at the dam is 72 feet, with much shallower areas found at the east end of the Lake. Precipitation varies in the Big Bear Watershed, with the west end at the dam receiving an average of 38 inches per year, while the east end of Big Bear Lake receives an average of 12 inches per year. Average annual precipitation in the Big Bear watershed is 24 inches. The Lake has overflowed to Bear Creek 10 times since its creation (1916, 1917, 1922, 1923, 1938, 1939, 1969, 1970, 1980, and 1983).

Past studies, starting in 1968/1969, have shown that Big Bear Lake is eutrophic and that the limiting nutrient is phosphorus. Studies conducted in 1992 found that Rathbone (Rathbun) Creek and Grout Creek, on the east and west ends of the Lake respectively, contributed the highest nutrient loadings to the lake in 1992. Nutrients (nitrogen and phosphorus) are available in the water column and sediment and are taken up by aquatic macrophytes and algae. Nutrients are also bound in living and dead organic material. Decomposition of this organic material and plant and algal respiration consumes dissolved oxygen, thereby depleting the water column of dissolved oxygen. After decomposition, the nutrients are cycled back into a usable form. Oxygen depletion in the hypolimnion (the lower colder water layer) results in anoxic conditions, which in turn result in the release of nutrients back into the water column promoting more algae and aquatic macrophyte production. Although aquatic macrophytes provide protection from shoreline erosion, habitat for fish and other aquatic biota and waterfowl habitat, the nuisance aquatic plant, Eurasian watermilfoil (*Myriophyllum spicatum*), has out-competed native species and obstructed recreational activities on the Lake (see also Item 6 on the March 15, 2002 agenda).

Decreased dissolved oxygen levels in the hypolimnion also affect the coldwater fishery, such as trout. As the temperature of the water increases during the summer, trout migrate toward the cooler water. However, if dissolved oxygen levels are decreased in the deeper waters, then the fish become stressed and fish kills may occur. Also, with an increase in nutrients, nuisance fish such as carp can increase in numbers. Furthermore, carp are bottom dwelling fish and can stir up sediment, thereby promoting the internal re-suspension of nutrients.

Metals have historically been present in the Lake and some tributaries. In studies conducted in 1992 and 1993, mercury and copper concentrations in the Lake and in several of the tributaries exceeded applicable water quality criteria. In addition, copper was also detected at elevated levels in *Corbicula* (freshwater clams) at most Lake and tributary stations. At the same time, however, chronic toxicity bioassays were inconclusive as to whether the presence of metals was causing a toxic response in test organisms.

In 1994, the Regional Board placed Big Bear Lake on the Clean Water Act Section 303(d) list of impaired waterbodies. The causes of the impairment were identified as nutrient inputs, noxious aquatic plants, sedimentation, and metals. In addition, Grout Creek was listed for metals (copper and mercury) and nutrients; Knickerbocker Creek for metals and pathogens; Rathbone (Rathbun) Creek for nutrients and sedimentation; and Summit Creek for nutrients. For any waterbody listed on the Section 303(d) list, federal law requires that a total maximum daily load (TMDL) be established to address the impairment.

Big Bear Lake TMDL Task Force

Board staff initiated the development of TMDLs for waterbodies in the Big Bear Lake watershed in 2000. Since that time, Big Bear Municipal Water District (BBMWD) has taken a lead role in assisting Staff with the TMDL development effort. BBMWD has created the Big Bear TMDL Task Force (Task Force), which consists of a number of local agencies and private interest groups including the following: the City of Big Bear Lake; San Bernardino County Flood Control District (SBCFCD); Big Bear Area Regional Wastewater Treatment Authority (BBARWA); East Valley Resource Conservation District (EVRCD); Big Bear City Community Services District (BBCCSD); Bear Mountain Ski Resort; Snow Summit Ski Resort; California Department of Transportation; California Department of Fish and Game; Big Bear Department of Water and Power; marina owners; representatives from the local newspaper (the Grizzly); and Regional Board Staff. There has been very little participation by the Forest Service, most likely due to lack of staff and funds. Discussion and involvement with the Forest Service in the TMDL development process is one of the Task Force's priorities since the Forest Service is the primary landowner in the watershed.

BBMWD, acting on behalf of the Big Bear TMDL Task Force, has hired Tim Moore of Risk Sciences, Inc., as a consultant to develop and execute the appropriate studies to support TMDL development and to secure funding sources for the needed studies. The Task Force budget was created by a partnership of the BBMWD, the City of Big Bear Lake, San Bernardino County Flood Control District (SBCFCD), and the Big Bear Area Regional Wastewater Agency (BBARWA). The principal funding is split three ways, with BBMWD, City of Big Bear Lake and SBCFCD each contributing equal amounts. BBARWA contributes about 5% of the total budget. This Task Force was set up by the agencies themselves on a voluntary basis.

The Big Bear TMDL Task Force has initiated the data collection effort for evaluating and determining the extent to which metals are impairing Big Bear Lake. The Task Force has conducted fish tissue sampling along with water column and sediment sampling for metals.

Based on the results so far, it is likely that the Task Force will request that Board staff recommend delisting of Big Bear Lake and the tributaries for metals during the next update of the 303(d) list. The probable cause for the elevated copper levels in fish, water column and sediment that were measured previously was likely due to the fact that copper sulfate was added to the Lake during the 1980s to control algal blooms. Copper sulfate has not been added to the Lake since the 1980s. Additional studies, including an investigation of the quantities of copper sulfate applied to the Lake and the frequency of copper sulfate application, along with additional water column, fish tissue and sediment sampling for metals, are ongoing.

In addition to the funding provided by the Task Force members, BBMWD and the Task Force have been very successful in obtaining additional funds to support TMDL development activities. The Regional Board has contracted with BBMWD using state TMDL funds to develop additional data on the nutrient cycle in the lake. Based on existing data, phosphorus is the primary nutrient problem within Big Bear Lake. It is believed that most of the phosphorus is being released from the sediment and recycled back into the Lake for use by the biota. This internal loading of phosphorus will be quantified within the next year under a contract with the BBMWD. In addition, monitoring of nutrients in the water column and sediment was conducted during 2001, with monitoring to continue through 2002 through a nutrient monitoring contract with the BBMWD.

BBMWD has received a Proposition 13 grant to evaluate alternative strategies for reducing and controlling legacy nutrient contamination (total phosphorus) from in-lake sources (i.e., sediments and aquatic macrophytes). Remediation strategies, including aquatic weed harvesting, herbicide and alum treatment, will be assessed as to their efficiency and effectiveness in controlling phosphorus. Pilot treatments in two to three selected bays will be carried out and will include pre- and post-treatment comparisons of water column concentrations of total phosphorus, dissolved phosphorus and chlorophyll a. Assessments of macrophyte density will also be conducted. Based on the results from these pilot studies, a recommendation for full lake treatment is expected to be part of the nutrient TMDL implementation. Prior to any treatment applications, baseline conditions in the Lake, including quantitative fish and invertebrate collections, phytoplankton surveys, and analyses for bioaccumulative substances in fish and macroinvertebrate populations, will be conducted. A database and reporting system will also be developed so that the interested public may access water quality information on Big Bear Lake via the BBMWD website.

BBMWD has also received a nonpoint source [319(h)] grant to conduct a treatment of SONAR, an aquatic herbicide, in selected portions of Big Bear Lake (again, see Item 6 in the March 15, 2002 agenda). Historically, BBMWD has relied on the use of aquatic harvesters to remove the large amounts of aquatic plants; however, the noxious aquatic weed problem has not been solved. The harvesters can only cut so much per season, never entirely removing all of the aquatic plants. There are approximately 800 acres of total plant mass in Big Bear Lake, yet only about 200-250 acres are controlled each year by harvesting. BBMWD and the Task Force believe that reducing the internal loading of nutrients will require a multi-phase approach. As the noxious aquatic plants decay, they produce detritus containing nutrients which contribute to the nutrient loading of the Lake. By using SONAR to eradicate the aquatic plants, nutrient loads in the lake should be reduced. In addition, an alum treatment will ensure that the phosphorus in the sediment is not reintroduced into the water column and remains unavailable for algal and plant uptake. It is also critical that non-point source runoff of nutrients is controlled so that the problem does not recur.

Finally, BBMWD has invited the US Army Corps of Engineers to perform a reconnaissance study of Big Bear Lake. This survey will take place during March or April of this year and it is hoped that this study will be the first step in gaining additional Federal funding for future projects in Big Bear Lake.

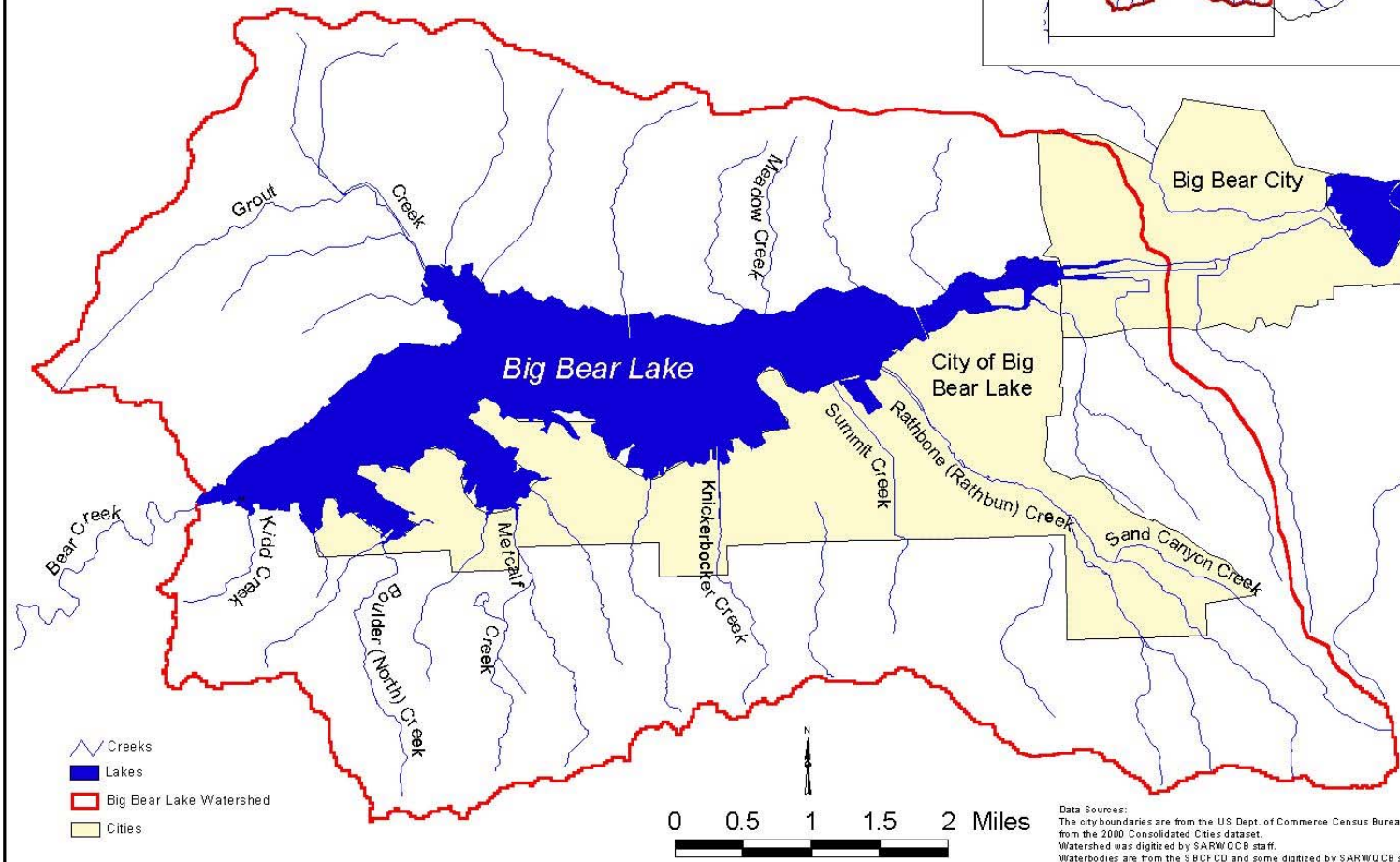
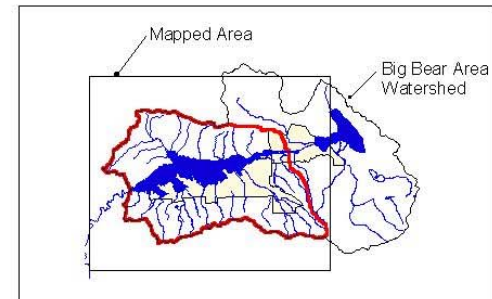
Summary

The Big Bear TMDL Task Force is focusing on both short-term and long-term solutions for Big Bear Lake. The watershed stakeholders have shown great interest in developing the TMDLs and through the voluntary development of their Task Force Budget have demonstrated their commitment to work together to solve problems. It is clear that these stakeholders have a real interest in ensuring that the Lake's beneficial uses are protected so that the Big Bear area can and will remain a significant recreational and wildlife resource for millions of Californians.

The timeline for all Big Bear Lake TMDLs activities, including tributaries, is as follows:

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| December 2002 | ⇒ Identify sediment, nutrients and pathogen TMDL numeric targets;
⇒ Report supporting metals delisting |
| December 2002
to March 2003 | ⇒ TMDL Allocations (proposed Basin Plan Amendment) and
Implementation Plan (sediment, nutrients and pathogens) |
| March 2003 | ⇒ Initiate Regional Board workshops for adoption of sediment, nutrient
and pathogen TMDLs (Basin Plan Amendment) |
| January 2004 | ⇒ Tentative Regional Board Adoption |
| July 2004 | ⇒ Tentative State Board Adoption |
| October 2004 | ⇒ Tentative Office of Administrative Law Approval |
| January 2005 | ⇒ TMDLs due to USEPA;
⇒ Tentative recommendation to Regional Board for delisting of metals |

BIG BEAR LAKE WATERSHED



Data Sources:
 The city boundaries are from the US Dept. of Commerce Census Bureau TIGER/Line from the 2000 Consolidated Cities dataset.
 Watershed was digitized by SARWOCB staff.
 Waterbodies are from the SBCECD and some digitized by SARWOCB staff.